Knowledge.

With which is incorporated Hardwicke's Science Gossip, and the Illustrated Scientific News.

A Monthly Record of Science.

Conducted by Wilfred Mark Webb, F.L.S., and E. S. Grew, M.A.

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SCIENCE AND THE STATE.

By JOHN BUTLER BURKE, M.A.

(Camb. and Dubl.)

RECENT mobilisation of industry for the supply of munitions may be all that could be desired to meet the requirements of the moment; and Mr. Lloyd George, as Minister for the Department, should be trusted no doubt to do everything in his power—that is, everything that is possible—to secure the effective organisation of this branch of the nation's work. But unfortunately, though munitions play a most important part in warfare, the crushing of the German military power—which, after all, is our aim in waging this war—will require the complete organisation of all the scientific work of this country in every branch of its numerous applications.

Sir Ronald Ross and others have made many useful and ingenious suggestions upon this point during the past two years. The idea of an Inventions Department may perhaps be not altogether novel; and the various Government departments, such as the Admiralty, the War Office, and the Board of Trade, will doubtless endeavour to take advantage of the innumerable suggestions with which they have been overwhelmed. The Admiralty in particular has invited suggestions from inventors; and no doubt the patents applied for will be carefully scrutinised for novel ideas which may be of some service to the enemy as well as to ourselves. In fact, the Naval Inventions Board, with Lord Fisher as chairman, has a nice piece of work cut out for it. But it is not merely naval inventions that are required. Other types of activity must be pushed with vigour.

I am not one of those who believe in denouncing the British Government and the British people for want of intelligence and lack of foresight. As Professor Schuster remarked at Manchester, the organisation of our great Empire testifies to no such lack of organising capacity on our part. Nothing is easier than to abuse and underrate the work that we know nothing of. But he who can abuse and underrate the greatness and success of that great Empire on which the sun never sets—nay, more, ignore its very existence—must be poor indeed in mind and soul! Such carping criticisms often do more harm to those that give than to those who take them, especially when they are taken lying down. I believe that, on the whole, the administration of our Government departments, considering the difficulties involved, is as efficient as it could well be, and in fully competent hands, notwithstanding the plaintive cries of disappointed cranks and the echoes of their shrill and timorous voices in the yellow press. Those who know to their own sorrow the trials of having to listen with courteous and

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deferential attention to the wonderful tales and plans of men who do not understand the elements of science, and do not know clearly what they are talking about, can sympathise with the various Government departments in this respect.

Only the other day Mr. Asquith stated in the House of Commons that the Government was in close touch with scientific men. If more is not known about their doings surely is it not because such proceedings are preferably carried out in private, rather than in the public eye, which could serve no purpose but to help the enemy? This perpetual carping that the Government does not know where to go for advice is becoming tiresome, not to say irritating. There are numerous consultants in London. Victoria Street swarms with them, as the Temple does with barristers. To say that His Majesty's Government is unable to ascertain where sound advice can be obtained is really embarrassing in the extreme. There are many engineering, electrical, chemical, and other scientific societies in London, not to mention the universities throughout the country: these render an appeal to any particular one not always necessary, since, as it will be admitted, the purely theoretical work for which the Royal Society is distinguished is not always what may be required. For certain matters many would prefer Faraday House, the Faraday Society, the Röntgen Society, the Society of Electrical Engineers, the Chemical Society, the Physical Society, and so on, to the Royal Society itself. Just as advice which is unsought is seldom accepted, so are gratuitous services seldom appreciated at their full value. The work of those who do things for nothing is often valued at the price attached to it, nothing! Nevertheless, the service which these societies can render is very great indeed, and there is no desire on my part to disparage or underrate it. Let it, however, not damp or otherwise injure the profession of scientific consultants in this country, many of the members of which are Fellows of the Royal Society; nor let private enterprise and originality be stifled by the overbearing and perhaps overwhelming influence of organised effort when once it is set going. The conspicuous absence of originality in Germany is, I think, not due to any natural incapacity or lack of genius in the Teutonic race, but to the crushing influence of its organisations; very useful in their own way, but very discouraging to individuals; and, after all, do not new ideas come from individuals rather than committees of societies? These serve rather to sift and circulate the information acquired by discoveries. Now let not what I say be misunderstood. I hold no brief for the Government or the Royal Society, nor have I any prejudices in favour of one rather than the other, except that the Government forms the responsible party in this war; and, so far as its political significance goes, all other societies are, in fact, politically irresponsible.

The Minister of Munitions, the President of the Board of Trade, and the Minister of Education, together with the President of the Council, keep in close and intimate touch with each other, so that there are apparently innumerable sub-committees for dealing with particular matters. Whitehall is, indeed, too well organised in the opinion of some people, who complain of the amount of red-tape and order that prevails therein. There is a curious inconsistency, for these complaints usually come from the same quarter. Something might be done to utilise the resources of the Science and Art Department in South Kensington and the Board of Agriculture for the prosecution of scientific research, with the addition of further grants for that purpose; whilst no objection could be raised to the reorganisation of the Science and Art Department into a proper Science Office, with a Minister of Science in the Cabinet.

The successful carrying out of research in pure science is a necessity in time of peace rather than of war. If we merely tried to sift the volumes of knowledge which have already been written, and left the attainment of further knowledge to some later date after the war, we should be preparing to concentrate our attention in the right direction. The Royal Society no doubt will be willing to do this if necessary; but it is quite clear that the special training of most of its members is in pure science, whilst what the occasion needs is useful invention based upon the principles of discoveries already made. We do know how far the important researches in progress at the National Physical Laboratory have been of service to aviators. The further knowledge attained by them cannot but be of use in time. But to say that most researches in pure science are of much importance at the present time is perhaps comparable with the suggestion that marriages should be particularly encouraged just now, so that as many babies as possible might be born during the war. Unfortunately, even if the birth-rate were quadrupled, no advantage whatever would be gained at the present juncture. We cannot send babies to the front, and only the number of women incapacitated would be increased proportionately.

The same argument applies to researches in pure science. Unless the war is likely to last for very many years, no fear need be entertained as to the next generation of Englishmen or the discoveries of science. Nay, rather is it desirable for economy of time and space, as well as pounds, that not only "war marriages" just now should be discouraged, but that pure researches in science should for the time being be discouraged too.

Let not the timid be frightened, or the apprehensive look aghast. I mean this in all earnestness.

Economy and efficiency must go together. The potential values of these are great indeed, and in time of peace might be considered indispensable, like education, which is the cultivation of the brain power of the nation. Education cannot be dispensed with. In this respect, there is no country in the world that spends so much in endeavouring to draw out the natural talent of its youth as England does. The scholarship system has served to attract the gifted youth of this country into the paths of industry, so that by means of the educational ladder men might rise on stepping-stones of their fathers and their dead selves to higher things.

I venture to think that the alleged abuse of the system as applied to the sons of rich men at the great public schools and universities is a fallacy, for the sons of rich men often need a greater stimulus to effort ; and the most prized rewards to the father or the son, even in early years, is that which adds to his allowance and stimulates the ambition for money as well as fame, not the least infirmity of ambitious minds, and we know the honourable place which England holds in this respect among the nations of the world.

In after life many of these scholarship men do nothing in research, but they do something else, and in most cases devote their energies to adding, if not to the world's knowledge, at any rate to the world's wealth and efficiency ; but many do take to research. In Germany, however, those who do so are not always or usually the best men, but those who have the best opportunities for continuing their work. That is either because they are those who contentedly live humbly all their lives, or else they are the sons of ***nouveaux riches*** who despise money because their fathers made it for them. The number of such in Germany is amazing, and it is unnecessary to go into details on this point. In my opinion, it may safely be affirmed that, with a few remarkable exceptions, the amount of money a man makes at his profession is a very fair measure of his success thereat.

For these reasons I have from time to time advocated the encouragement of scientific discovery and invention as an industry in itself, researches into apparently useless knowledge being regarded—as they should be—as a branch of every industry that prospers through invention. A reserve fund might well exist for the prosecution of pure science by every large manufacturing concern, but this is not what is most needed to-day.

The assistance which the State can render would be more appreciated if it could give guarantees to inventors in floating new companies rather than actual grants, if these are to be merely—as they have been—of trifling amounts. Enterprising schemes, such as frequently come before the Society of Arts, should be financially encouraged by the Government itself. Thus the (suggested) formation of a Research Syndicate, as I proposed in the *Westminster Gazette* (June and July, 1914), leading as it did to a lengthy correspondence on the subject, would become the parent company of many others. Financiers in the City will not risk money on an enterprise which may not pay a dividend for years. But the State can, and should do so. Such enterprise lies between pure business and purely philanthropic undertakings, and in giving guarantees to inventors and promoters after careful consideration of the merits of each scheme, it would be rendering an invaluable assistance to business and to science ; whilst a percentage of the profits from the successful ventures, allotted to the State, would more than compensate the losses from the failures, if due caution be exercised in giving such assistance.

Since, then, the State could encourage the scientific men of this country, and give the security to inventors and business men which would enable them to raise the necessary funds, for parent syndicates, usually needing but a few thousand pounds for each invention, its assistance would be invaluable ; and the fact that a committe of experts could advise on the scientific and financial value of each undertaking should render the proposal both economically sound and scientifically fruitful.

Let me then, with a slight digression, be permitted to quote the greatest of Greek statesmen in the past, as M. Venizelos is at the present day, in answer to the question, " What shall we do ? " : " First let us know what we desire. He who knows what he wants may possibly fail. He who does not cannot succeed. Is it your wish to beat your enemy utterly ? I was what you call a civilian. But I know that the great principle common to all great transactions is simply to throw all your strength upon the one object which you wish to carry ; for which end you must first know what that object is ; for which end, again, you must be in earnest. If you are not that, I could not aid you, except by rousing you. If you are, you would do without me."

We are, indeed, in earnest, and very much so too, and all we require is the necessary guarantee to enable financiers to exploit our ideas and the fruits of our labours. This having been done, commerce and the spirit of enterprise will secure the rest. The wealth of this nation will multiply a hundred, perhaps a thousand fold, and that of Germany will gradually dwindle away while she suffers, if she does not perish, in the struggle for many days to come in unutterable woe, till her iniquity be avenged, and men are free again to pursue the path of knowledge with impunity in the cause of civilisation, of humanity, and of the love of truth.

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THE FACE OF THE SKY FOR APRIL.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

TABLE 7.

Date.	Sun. R.A.	Sun. Dec.	Moon. R.A.	Moon. Dec.	Mercury. R.A.	Mercury. Dec.	Venus. R.A.	Venus. Dec.	Mars. R.A.	Mars. Dec.	Saturn. R.A.	Saturn. Dec.	Neptune. R.A.	Neptune. Dec.
Greenwich Noon.	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°
Apr. 5	0 56·6	N. 6·1	3 0·3	N. 22·2	0 23·9	N. 0·6	3 48·7	N. 22·6	8 59·6	N. 20·1	6 43·9	N. 22·8	8 8·0	N. 19·9
„ 10	1 14·9	7·9	7 23·6	N. 23·4	0 59·3	4·9	4 11·2	23·9	9 3·2	19·7	6 45·0	22·8	8 7·9	19·9
„ 15	1 33·3	9·7	11 20·4	N. 0·3	1 36·8	9·5	4 33·6	25·1	9 7·7	19·2	6 46·2	22·8	8 8·0	19·9
„ 20	1 51·9	11·5	15 50·0	S. 24·7	2 16·1	14·0	4 55·8	25·9	9 12·9	18·6	6 47·6	22·7	8 8·0	19·9
„ 25	2 10·6	13·2	20 57·6	S. 16·4	2 56·0	18·0	5 17·4	26·6	9 18·8	18·0	6 49·2	22·7	8 8·2	19·9
„ 30	2 29·6	N. 14·8	1 3·9	N. 12·1	3 34·0	N. 21·2	5 38·5	N. 26·9	9 25·3	N. 17·4	6 50·9	N. 22·7	8 8·4	N. 19·9

TABLE 8.

Date.	Greenwich Noon. Sun. P	Sun. B	Sun. L	Mars. P	Mars. B	Mars. L	Mars. T	Midnight. Moon. P
	°	°	°	°	°	°	h. m.	°
Apr. 5 ...	−26·4	−6·2	142·0	Apr. 6 ...	− 1·5	+15·4	195·3	11 16 *e*	Apr. 5	−14·9
„ 10 ...	26·4	5·9	76·0	„ 12 ...	− 0·8	16·0	139·4	2 27 *m*	„ 10	+ 8·9
„ 15 ...	26·2	5·5	10·0	„ 18 ...	+ 0·1	16·6	83·3	6 18 *m*	„ 15	+22·5
„ 20 ...	25·8	5·1	303·9	„ 24 ...	+ 1·1	17·3	26·8	10 10 *m*	„ 20	+10·4
„ 25 ...	25·2	4·6	237·9	„ 30 ...	+ 2·3	+18·0	330·1	2 3 *e*	„ 25	−16·6
„ 30 ...	−24·4	−4·1	171·8						„ 30	−21·6

P is the position angle of the North end of the body's axis measured eastward from the North point of the disc. B, L are the helio-(planeto-) graphical latitude and longitude of the centre of the disc. T is the time of transit of the zero meridian across the centre of the disc. To find intermediate passages of the zero meridian of Mars apply multiples of $24^h\ 38^m$.

The data for the Moon in Table 8 are given for Greenwich Midnight, *i.e.*, the Midnight at the end of the given day. Those for the planets were given for midnight last year, but are now given for Noon.

The letters *m*, *e* stand for morning, evening. The day is taken as beginning at midnight.

THE SUN is moving Northward with slightly diminishing speed. Its semi-diameter diminishes from 16′ 1″ to 15′ 54″. Sunrise changes from $5^h\ 39^m$ to $4^h\ 36^m$; sunset from $6^h\ 30^m$ to $7^h\ 18^m$. There is now considerable solar activity, and a constant watch should be kept on the disc.

MERCURY is a morning star till the 14th, when it passes Superior Conjuction and becomes an evening Star. It is fairly well placed for observation at the end of April. Semi-diameter increases from 2½″ to 3″. Illumination, nine-tenths at beginning of month, full in middle, ¾ at end.

VENUS is an evening star, well placed for observation, being North of the Sun, and at its Elongation, 45° 39′ from Sun, which is reached on 24th. At the end of April it does not set till $11^h\ 30^m$ *e*. Semi-diameter increases from 9″ to 12¾″. Illumination diminishes from six-tenths to one-half. There will be a good opportunity of picking up Venus in daylight on April 6th, as it will be 1½° South of Moon at noon.

THE MOON.—New $2^d\ 4^h\ 21^m$ *e*. First quarter $10^d\ 2^h\ 36^m$ *e*. Full $18^d\ 5^h\ 7^m$ *m*. Last quarter $24^d\ 10^h\ 38^m$ *e*. Apogee $9^d\ 2^h$ *e*. Perigee 21^d Noon. Semi-diameter 14′ 48″, 16′ 20″ respectively. Maximum librations 3^d 5° W., 3^d 7° S., 15^d 6° E., 18^d 7° N. The letters indicate the region of the Moon's limb brought into view by libration. E., W. are with reference to our sky, not as they would appear to an observer on the Moon. (See Table 10.)

MARS is in Cancer, and has begun to advance. It was in opposition on Feb. 10th. Semi-diameter 4½″. Defect of illumination 0″·8. The North Pole of the planet is now turned towards the Earth and Sun. The planet is in the part of its orbit that corresponds with the first half of June on Earth. The Summer solstice of Mars' Northern Hemisphere will be reached on May 6th. The recent opposition was unfavourable as regards distance, but favourable as regards altitude.

JUPITER is too near to the Sun for convenient observation, being in conjunction on April 1. No satellite phenomena are given this month.

SATURN is an evening star in Gemini, and has begun to advance. It is 2° South of Moon on evening of 9th. Angle P−6°·9, B−25°·6. Polar semi-diameter 8¼″, major axis of ring 41″, minor 17½″. Eastern elongations of Tethys (every fourth given) $8^d\ 0^h{\cdot}3$ *e*, $16^d\ 1^h{\cdot}6$ *m*, $23^d\ 2^h{\cdot}9$ *e*, May $1^d\ 4^h{\cdot}2$ *m*; of Dione (every third given) $2^d\ 10^h{\cdot}3$ *e*, $11^d\ 3^h{\cdot}4$ *m*, $19^d\ 8^h{\cdot}6$ *m*, $27^d\ 1^h{\cdot}7$ *e*, May $5^d\ 6^h{\cdot}9$ *e*; of Rhea (every second given) $3^d\ 4^h{\cdot}7$ *e*, $12^d\ 5^h{\cdot}6$ *e*, $21^d\ 6^h{\cdot}6$ *e*, $30^d\ 7^h{\cdot}7$ *e*. For Titan and Japetus E., W. stand for Eastern and Western elongations; S., I. for Superior and Inferior Conjunctions. Titan $2^d\ 1^h{\cdot}2$ *e* W., $10^d\ 8^h\ 5$ *e* E., $18^d\ 1^h{\cdot}4$ *e* W., $26^d\ 8^h{\cdot}4$ *e* E., May $4^d\ 1^h{\cdot}5$ *e* W., $9^d\ 10^h{\cdot}0$ *e* E., $17^d\ 2^h{\cdot}5$ *e* W., $25^d\ 8^h{\cdot}9$ *e* E. Japetus $3^d\ 8^h{\cdot}2$ *e* W., $23^d\ 9^h{\cdot}0$ *m* S.

URANUS is a morning star, but badly placed for Northern observers. It was in conjunction with the Sun on February 5th.

NEPTUNE is in Cancer. It begins to advance on 10th. Semi-diameter 1″, magnitude 7·7.

METEOR SHOWERS (from Mr. Denning's List):—

Date.	Radiant. R.A.	Radiant. Dec.	Remarks.
Mar. to May ...	263°	+ 62°	Rather swift.
Apr. 12–24 ...	210	− 10	Slow: fireball.
,, 16–25 ...	301	+ 23	Swift: streaks.
,, 18–23 ...	189	− 31	Slow: long.
,, 19 to May 9	201	+ 8	Slow.
,, 20–22 ...	271	+ 33	Lyrid shower, swift.
,, 20–25 ...	218	− 31	Slow: long paths.
,, 30 ...	291	+ 59	Rather slow.
Apr.–May ...	193	+ 58	Slow: yellow.
Apr.–May ...	296	0	Swift: streaks.

The Lyrids frequently form a conspicuous shower.

GREENWICH TIMES OF MERIDIAN TRANSIT OF CERTAIN BRIGHT STARS.—These are given to facilitate the determination of time by observations with small transit instruments. The times for intermediate days may be obtained by simple interpolation. The Greenwich time of the stars crossing the meridians of other places may be obtained by expressing the longitude of these places in time, diminishing them by $9^s \cdot 83$ per hour, and proportionately for fractions of an hour, then applying the result to the tabular time—positively for West longitudes, negatively for East ones. (See Table 9.)

Observers who know Greenwich Time can use the Table to obtain their South Point.

SUN after clock April 1, $238^s \cdot 83$; April 6, $150^s \cdot 65$; April 11, $67^s \cdot 20$; before clock, April 16, $9^s \cdot 46$; April 21, $77^s \cdot 14$; April 26, $133^s \cdot 66$; May 1, $177^s \cdot 44$. These are the equations of time for the moment of solar transit at Greenwich.

VARIABLE STARS.—Stars reaching their maxima in or near April, 1916, are included. The lists in recent months may also be consulted. (See Table 11.)

TABLE 9.

Day.	Regulus. N. Dec. 12° 22′.	β Leonis. N. Dec. 15° 2′.	Spica. S. Dec. 10° 44′.
	h. m. s.	h. m. s.	h. m. s.
Mar. 30	9 32 13·11 *e*	11 12 49·37 *e*	0 48 32·87* *m*
Apr. 9	8 52 53·95 *e*	10 33 30·29	0 9 13·89* *m*
,, 19	8 13 34·75 *e*	9 54 11·17 *e*	11 29 54·87 *e*
,, 29	7 34 15·54 *e*	9 14 52·02 *e*	10 50 35·83 *e*

* Morning of March 31, April 10 respectively.

TABLE 10. Occultations of Stars by the Moon visible at Greenwich.

Date.	Star's Name.	Magnitude.	Disappearance. Time.	Disappearance. Angle from N. to E.	Reäppearance. Time.	Reäppearance. Angle from N. to E.
1916.			h. m.	°	h. m.	°
April 8 ...	139 Tauri	4·7	5 46 *e*	117	7 3 *e*	260
,, 9 ...	WZC 476	6·7	8 21 *e*	130	—	—
,, 11 ...	WZC 538	7·0	1 12 *m*	40	—	—
,, 16 ...	BD − 8°·3366	7·0	8 20 *e*	159	—	—
,, 16 ...	q Virginis	5·3	9 38 *e*	134	10 50 *e*	295

From New to Full, disappearances take place at the Dark Limb; from Full to New, reäppearances.

TABLE 11. LONG-PERIOD VARIABLE STARS.

Star.	Right Ascension. h. m. s.	Declination. ° ′	Magnitudes.	Period. d.	Date of Maximum.
V Cancri	8 16 53	+17 34	7·1 to 12·8	272	1916—May 3
R Comae...	11 59 54	+19 16	7·3 to 14·6	362	,, May 28
R Corvi	12 15 13	−18 47	5·9 to 12·5	318	,, May 9
V Ursae Min.	13 37 10	+74 45	7·5 to 8·7	71	,, May 7
R Camelopardi	14 23 35	+84 13	7·2 to 13·3	270	,, Apr. 5
R S Librae	15 19 22	−22 37	7·1 to 13·0	217	,, May 9
S Ursae Min.	15 32 47	+78 55	7·2 to 11·6	323	,, May 8
R Serpentis	15 46 47	+15 23	5·8 to 13·5	357	,, Apr. 25
R Draconis	16 32 25	+66 56	6·4 to 13·0	245	,, Apr. 3

Minima of Algol $6^d\ 5^h \cdot 3\ m$, $9^d\ 2^h \cdot 1\ m$, $11^d\ 10^h \cdot 9\ e$, $14^d\ 7^h \cdot 7\ e$; $29^d\ 3^h \cdot 6\ m$, May $2^d\ 0^h \cdot 4\ m$. Period $2^d\ 20^h\ 48^m \cdot 9$.

Principal Minima of β Lyrae $5^d\ 2^h \cdot 4\ e$, $18^d\ 0^h \cdot 5\ e$, May $1^d\ 10^h \cdot 6m$. Period $12^d\ 21^h\ 47^m \cdot 5$.

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NOTES.

ASTRONOMY.

By A. C. D. Crommelin, B.A., D.Sc., F.R.A.S.

THE PROBLEM OF THREE BODIES.—The general case of the problem of three bodies has engaged the attention of mathematicians for nearly two centuries. The cases that arise in lunar and planetary theories have been solved with practical completeness, so far as our own times are concerned. In these cases there is one preponderant body, compared with which the perturbing actions are small. Thus we may look on the planetary tables as sufficiently exact for our own times; they are not, however, available for very distant epochs, as there are terms depending on the square or higher powers of the time which would ultimately swamp the other terms. Cases where the three bodies are all of comparable mass are much more difficult. Laplace noted a few exact solutions, one being the case where the bodies continually occupy the angles of an equilateral triangle; another where they are all continually in a straight line. (The Trojan asteroids afford an example of the first case, as they form an equilateral triangle with the Sun and Jupiter.) A few other cases have been solved by periodic orbits, that is, by showing that the initial configurations would be exactly reproduced at certain intervals, which in some cases consist of a large number of revolutions. If the motion be calculated at short intervals during one of these periods (the method known as "Mechanical Quadratures" is available for this purpose), it will reproduce itself in all succeeding periods. Poincaré showed that a periodic solution could be found approximating, as nearly as we pleased, to any configuration; but in most cases it would involve such a large number of revolutions as to be practically useless. A dramatic incident took place immediately after Poincaré had expressed his conviction that the general case was beyond the power of existing mathematics to solve: a young Finnish mathematician—Mr. Karl F. Sundmann, of Helsingfors—showed that if, instead of using the time as the independent variable, a complicated function of the time and the mutual distances were employed, the series that were previously divergent when employed for distant epochs would become convergent. It must be admitted that the new independent variable is of a very forbidding aspect; it is:

$$\tan h \int \pi dt \Big/ 4\,\mathfrak{L}\left(1-e^{-r_0/l}\right)\left(1-e^{-r_1/l}\right)\left(1-e^{-r_2/l}\right)$$

where r_0, r_1, r_2 are the mutual distances, and $\mathfrak{L}$, l are constants depending on the initial conditions. From the presence of the hyperbolic tangent, the independent variable always lies between -1 and $+1$, the former being its value for past eternity, the latter for future eternity. It follows that for distant epochs the quantity is very nearly 1, and the resulting configuration of the bodies extremely sensitive to small changes in the independent variable. It is doubtful whether the new method can be put into a shape that will be of practical utility for distant epochs, but even the theoretical solution of this famous problem is very interesting. I am indebted to an article in *The Observatory* for last November for the above particulars.

Mr. Sundmann has shown that he is not merely a theoretical mathematician, but a practical astronomer also, by designing an instrument for computing planetary perturbations, especially those of minor planets, by Jupiter. Such an instrument has many points in common with tide-predicting machines. But there are some new features. One is a device which, when the perturbations reach a certain value, automatically applies their sum to the part of the machine that represents the perturbed planet. In this way the perturbations of higher orders are virtually included. Another device is a change of scale when the perturbations become very large, as in the case of a near approach to Jupiter. Without this device the scale would be too small in other parts of the orbit. The direct and indirect perturbations are computed separately, the latter being obtained by making the perturbed planet coincide with the Sun. Mr. Sundmann admits that the cost of the machine would be very high. Still, it would soon pay its way in any office where much work of this character was undertaken.

THE STARS OF THE SOUTHERN SKIES.—Mrs. Evershed (*née* Miss M. A. Orr) has brought out a charming little book under this title (published by Longmans, Green, and Co., price 2/-). She begins with the naked-eye aspect of the southern constellations, and goes on to the revelations of the telescope and the spectroscope. Chapters are devoted to Eta Argus, the Clouds of Magellan, and other objects of special interest.

She reminds us that the "Southern Cross," though a modern name, was known to the ancients, forming one of the hind legs of the Centaur. Alpha and Beta Centauri mark the two front legs. It is of interest to recall that, though these stars are now invisible in England, they were visible here about 2500 B.C.; and Sir Norman Lockyer thinks it probable that some of the old stone circles marked their rising-points.

Mr. R. T. A. Innes has found a 12th-magnitude star, 2° 13′ distant from α Centauri, which has a proper motion at least equal to that of α (3″·68 per annum in position angle 281°·4) in almost the same direction. It seems likely that it is a distant member of the α Centauri system. It is deep yellow, and two magnitudes brighter visually than photographically, so it is probably a dwarf star of Class M at an advanced stage of its career.

Its position for 1900 is: R.A. 14h. 22m. 55s., S. Dec. 62° 2′.

THE GOLD MEDAL OF THE R.A.S. has been awarded to Dr. Dreyer, Director of the Armagh Observatory, for his catalogues of nebulae and his historical researches.

Professor Simpson, in handing the medal to him, alluded to the fact that the medal has only once before been given for historical work—to Professor Grant for his "History of Physical Astronomy." He explained this by the small number of astronomers who have devoted themselves to historical criticism. Most of them are content to take their facts about ancient and mediaeval astronomy at second hand. Dr. Dreyer has gone to the original documents, and has in many cases thrown a new light on their meaning, showing that some modern writers have exaggerated, while others have unduly belittled, the knowledge of the ancients. He has made a special study of the life and work of Tycho Brahé, and is now engaged in editing a sumptuous reprint of all his writings and observations. This will fill thirteen large volumes, of which two have already appeared. He points out, as an instance of good coming out of evil, that Tycho's overbearing manner and neglect of certain royal instructions were the cause of his leaving Denmark and going to Bohemia, where he met Kepler, who afterwards deduced from his observations the famous laws of planetary motion, which in turn were the foundation of Newton's discovery of universal gravitation.

The meeting of the Royal Astronomical Society, at which the medal was presented, also witnessed the formal admission of the first lady Fellows, a new charter sanctioning their admission having been granted during the past year. Miss Mary Proctor's name is of special interest to our readers, as she is the daughter of the founder of this Journal, and has carried on his lecturing work in England, America, Australia, and New Zealand.

THE TOTAL ECLIPSE OF FEBRUARY 3RD.—No news is yet to hand from South America. The weather in London was very unfavourable, and did not permit of a glimpse of the partial phase; but there was a temporary break in the clouds at 5h. 30m. (forty minutes after sunset), showing that the sky was much darker than on neighbouring evenings at the same hour. The reason this eclipse had such a notable effect on the illumination after sunset is that London lay near the prolongation of the central line, so that if we could have been raised thirty or forty miles into the air we should have seen a total eclipse at 5h. 32m.

DIMENSIONS OF SATURN'S SYSTEM.—Professor Lowell and Mr. Slipher have just issued the results of a new set of measures of the Saturnian system made between 1913 and 1915. The following are their results, corrected for irradiation, and reduced to the mean distance of the planet from the Sun: Outer diameter of Ring A, 39″·67; inner, 35″·27. Width of Cassini division, 0″·51. Outer diameter of Ring B, 33″·76; inner, 26″·43. Distance from inner edge of B to Ball, 4″·30. Inner diameter of Crepe Ring, 21″·93. Width of Crepe Ring, 2″·05. Distance from inner edge of Crepe Ring to Ball, 1″·79. Equatorial diameter of Ball, 17″·24. The oblateness of the planet, or the fraction

$$\frac{\text{equatorial minus polar}}{\text{equatorial diameter}}$$

was found to be 1/9·18.

One interesting point in measures of the Ring system is to examine whether they show any progressive change in the course of time, due to the Ring closing in on the planet. It will be remembered that Mr. R. A. Proctor, in his book "Saturn and its System," thought that the measures indicated such a change. Professor Lowell has compared his measures with older ones, and fails to find evidence of a change. He has detected a number of fine divisions, both on Rings A and B, and gives micrometric measures of their positions. Their positions in most cases correspond to commensurability with Mimas. Thus, reckoning from the inner edge of B, the one 1/4 way out corresponds to 3/8 period; 3/7 way out to 2/5 period; 4/7 way out to 3/7 period; the one nearly 1/3 way out to 4/9 period; the one more than 1/3 way out to 5/11 of Mimas' period.

In order to diminish irradiation, measures were chiefly made when the sky was fairly bright, some even in daylight. The difference between these and those made in a dark sky is very marked. It is worth reminding observers that we only see Saturn at its maximum oblateness when the Ring is seen edgewise; at other times a north and south diameter is appreciably longer than the actual polar diameter.

CHEMISTRY.

By C. AINSWORTH MITCHELL, B.A. (OXON), F.I.C.

PHOSPHORESCENT CALCIUM SULPHIDE.—The property possessed by impure calcium sulphide of emitting light in the dark after having been exposed to a bright light was discovered by Canton in 1761. His preparation of "phosphorus" was obtained by heating crushed oyster shells and sulphur together and exposing the fused mass to sunlight. The phosphorescence is not the result of a slow process of oxidation, for it has been shown to be produced by a specimen of the material which had been sealed up in a glass tube for over a century. Later investigation showed that perfectly pure calcium sulphide does not phosphoresce, but that the presence of traces of salts is necessary to produce the phenomenon.

A recent issue of the *Comptes Rendus* (1915, CLXI, 732) contains a paper, by M. P. Breteau, giving an account of his experiments on the production of highly phosphorescent calcium sulphide. One of the most active was made by heating precipitated chalk with thirty per cent. of its weight of powdered stick sulphur in a closed crucible for an hour, then impregnating the cold product with a trace of bismuth (0·0001 per cent. in the form of an alcoholic solution of basic bismuth nitrate), again heating the mixture for two hours longer at a dull-red heat, and then allowing the still closed crucible to cool slowly in the furnace. Products exhibiting less phosphorescence were made by impregnating the calcium sulphide with tungsten, molybdenum, or vanadium. The presence of sodium carbonate, or chloride, in the original mixture had either no effect or an injurious one on the phosphorescence, and impurities in these salts may have been the cause of the phosphorescence which Verneuil (*Comptes Rendus*, 1887, CIV, 501) observed with such fused mixtures.

ACTION OF LIGHT ON ASPHALTS.—The photo-chemical properties of various kinds of asphalts have been studied by Dr. P. Godrich (*Monatsh. Chem.*, 1915, XXXVI, 535; *Chem. Zeit.*, 1915, XXXIX, 832). Natural asphaltum will combine with a small proportion of sulphur chloride to form a darker product, which is still soluble in carbon bisulphide, and is more sensitive to light. Asphalt varies in its sensitiveness to light, but, whatever its origin, is made insoluble by exposure to any part of the spectrum when oxygen is also present.

Petroleum asphalts differ from the natural products in the fact that they lose their photo-chemical activity when treated with sulphur chloride. Without such treatment the residues from the distillation of crude Galician petroleum were more or less affected by light. For instance, when solutions of brown or black residues were dissolved in benzol and poured over zinc plates, films were left which, when covered with a glass negative and exposed to light, gave, on subsequent development with oil of turpentine, distinct, though not very permanent, images. This sensitiveness to light was not possessed by pitches containing paraffin wax, for these could be exposed to the light for several hours without undergoing alteration. Soft and semi-solid residues from the distillation of petroleum also gave no image after exposure to light beneath a negative.

GEOGRAPHY.

By ALEXANDER SCOTT, M.A., D.SC.

THE "WHANGIE."—This remarkable feature is situated in the Kilpatrick Hills, to the north-east of Glasgow, and consists of a large fissure, apparently produced by a mass of rock slipping away from one of the escarpments of the calciferous sandstone volcanic plateau. The crevice is two hundred feet long, at least thirty feet deep, and has a maximum width of ten feet. The two sides show a remarkable concordance, the salients on one side being represented by corresponding re-entrant angles on the other, so that there is no doubt that the rock mass has slipped from the cliff-face. In a recent description by G. W. Tyrrell (*Scot. Geog. Mag.*, January, 1916) a remarkable fact is pointed out; namely, that the severed mass seems to have moved upward as well as outward. The parallelism of the two sides precludes the idea that this is due to a tilt, either lateral or longitudinal, and the only feasible explanation is that the "Whangie" is the result of earthquake action, the severed portion receiving a slight upward motion, owing to it being projected forward through a large mass of talus. There is no evidence as to the date of origin, but Tyrrell concludes that it is possible that a severe earthquake, which occurred in 1608, and the epicentre of which was near Dumbarton, may have caused the rift.

RELATIONS OF THE CLYDE AND THE TWEED.—Although Sir Archibald Geikie's suggestion that the Clyde was formerly a consequent stream, and flowed into the sea through the Tweed valley, has been generally accepted, there are several difficulties which stand in the way of this idea. These are subjected to an exhausting examination in a recent paper by J. W. Gregory in *The Scottish Geographical*

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Magazine. If streams from Argyllshire flowed south-eastwards up the present Clyde Valley, and through the Biggar gap to the Tweed, the Clyde estuary must have been over one thousand feet higher than it is at present. The fact that the Tweed Valley to the east of the Biggar Gap is very narrow is a serious objection as a combined Clyde-Tweed river would be expected to cut a large valley. This narrowness is probably to be explained by the fact that the old valley was filled up by Glacial material, through which the present river is reëxcavating a channel. The pre-glacial Tweed valley must have been large enough for this Clyde-Tweed river, but this was completely filled up, and has only been partly reëxcavated. The question of the age of the separation of the two rivers is one of great difficulty. The valleys are later than the north-west and south-east dykes, which are probably Miocene in age; the former are also certainly pre-Glacial. It seems probable that they were initiated as a consequence of the Pliocene uplift, and that the separation of the two rivers but the assumption by the Clyde of its present abnormal direction took place at a time anterior to the Glacial period.

GEOLOGY.

By G. W. TYRRELL, F.G.S., A.R.C.S.

GEOLOGICAL HISTORY OF THE GREAT LAKES.—Three great monographs have been published within the last fifteen years by the United States Geological Survey on the Glacial deposits and history of the region about the Great Lakes of North America. The latest of these is entitled "The Pleistocene of Indiana and Michigan, and the History of the Great Lakes," by F. Leverett and F. B. Taylor; and is a ponderous, but interesting, quarto volume of five hundred and twenty-nine pages, forming Monograph 53 of the United States Geological Survey. It presents the most recently gathered facts and latest opinions concerning the vicissitudes of the enormous Glacial lakes, whose shrunken remnants even now form the greatest series of freshwater lakes in the world. The Glacial epoch in North America is now regarded as being made up of at least four distinct stages of glaciation, separated by intervening warm periods when the ice-sheet either shrank to relatively small proportions or disappeared altogether. The last of these ice advances deposited what is known as the "Wisconsin Drift," and this material covers most of that deposited during the earlier periods of glaciation.

The depressions in which the great lakes are now found certainly antedate the Glacial epoch. They were initiated towards the close of the Palaeozoic era, and, prior to the advance of the ice, were occupied by ordinary river systems which had excavated extensive valleys draining towards the north and north-east. Some time before the beginning, or possibly in the earlier part, of the Ice epoch, the northern lands were uplifted in such a way as to warp or tilt the region of these great valleys. This warping movement probably initiated the lakes, which were soon vastly extended by the ice advance to the south, thus ponding up all the northwardly draining rivers against the ice margin. The traces of these earlier lakes, however, were obliterated by the later advances of the ice, and the history which has now been deciphered in such detail is that of the latest or Wisconsin stage of glaciation. This has left easily recognisable marks, such as moraine systems and lake beaches, whereby this part of the history "is spread like an open book upon the surface of the lake region." The history is complex, and becomes more so as new facts are gathered. It is expressed by the distribution and relations of the various drift forms, and also by the remarkable effects of the ice upon the drainage. The ice margin "determined the location of the great rivers which flowed only temporarily from the ice or along its border, and it caused remarkable shiftings of their courses. Its most noteworthy effect, however, was the production of a complex succession of shifting and changing lakes—enlarging, falling, shrinking, combining, dividing, and rising—of large extent and frequent changes of outlet, coming at last to the lakes as they are to-day." The more stable phases gave rise to extraordinarily well-marked beaches, which have been given distinctive names. Other beaches, which were formed during rising phases, were partly or wholly obliterated by wave-action or by lake-deposits. Warping has continued over the whole area during the Glacial epoch, and its amount and direction has been registered automatically in the rise and fall of the levels of the beaches.

AGE OF THE TORRIDONIAN.—There are four great groups of pre-Cambrian rocks in the Scottish Highlands: the Lewisian Gneiss, the Moine Gneiss, the Dalradian Series, and the Torridonian Series. It is known that the Lewisian is the oldest of these, and forms the basement upon which the others have been laid down; but the age relations of the Moine, Dalradian, and Torridonian are uncertain, although the order tentatively assumed is that given above. This question of relative age is one of the fundamental problems of the Highlands, and definite evidence upon it is highly desirable. Consequently the recent discovery by Professor J. W. Gregory of pebbles of rocks, indistinguishable from typical Moine gneisses, as constituents of a Torridonian conglomerate, is likely to be important (*Geol. Mag.*, October, 1915). This conglomerate occurs on the northern shore of Little Loch Broom, and belongs to the Applecross or middle division of the Torridon Sandstone. The pebbles are banded siliceous gneisses of distinctive Moine types, associated with quartzites which are like those found occasionally within the Moine areas. These pebbles differ from the local Lewisian gneisses, but are indistinguishable from the two typical rocks of the nearest outcrop of the Moine Series. Another line of evidence, suggesting the derivation of the Torridonian from the Moine, is the prevalence of microcline felspar in the former series. Microcline is often abundant in the Moine rocks, but is not the typical felspar of the Lewisian. It has been suggested that the Moine gneiss is the eastern metamorphosed continuation of the Torridon Sandstone; but, if the latter contains pebbles of the Moine, it must therefore be a younger formation.

METEOROLOGY.

By WILLIAM MARRIOTT, F.R.MET.SOC.

CIRRUS CLOUD OBSERVATIONS IN VICTORIA.—*Bulletin* No. 10 of the Commonwealth Bureau of Meteorology is devoted to a discussion by Mr. E. T. Quayle on the "Relations between Cirrus Directions as observed at Melbourne and the Approach of the various Storm Systems affecting Victoria." As guides for the local forecaster, it may safely be said that there are no weather indications comparable in importance with those obtainable from the systematic study of cloud-forms, and of these cirrus types are easily first; and it is to the direction of the movement of these cloud-forms that the author confines his attention in this work. He urges that special attention should be given by observers to the movements of cirrus clouds, since these are our only cloud indication of the translation of air masses at high level, the direction of which appears to have a most important bearing upon storm developments at lower levels. The following may serve to illustrate this. It not infrequently happens—in the summer half of the year chiefly—that monsoonal conditions prevailing over Victoria are accompanied by quite hot weather, extensive thunderstorm developments, and in parts heavy rains, the clouds meanwhile, from cumulus base level to the higher cirrus wisps, moving slowly from some northerly point. If now cirrus clouds are observed in the western or south-western horizon coming up from a point between west and south, or the loftier cumulus summits appear to be caught in an upper current coming from such a direction, the end of the thunderstorm production is close at hand. The

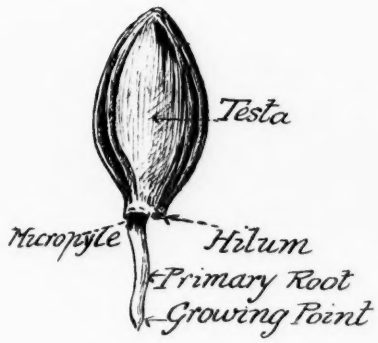

FIGURE 35.

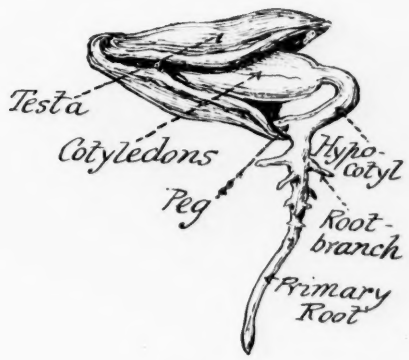

FIGURE 36.

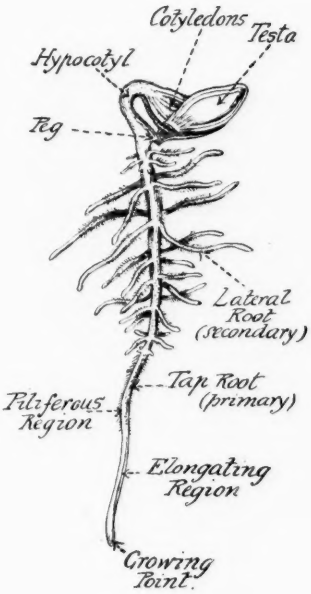

FIGURE 37.

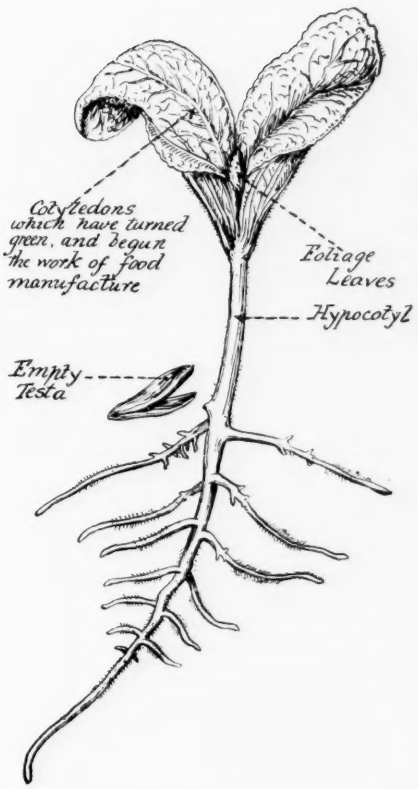

FIGURE 38.

THE DEVELOPMENT OF A VEGETABLE-MARROW SEEDLING.

(See page 67.)

FIGURE 39.
Larva of the beetle ***Caryoborus nucleorum*** feeding on a seed inside the fruit of *Attalea funifera* from Brazil.
Natural size.

FIGURE 40.

FIGURE 41.

FIGURE 42.

Ventral, dorsal, and lateral views of the pupa of ***Caryoborus***.
Twice natural size.

FIGURE 43.
Caryoborus, adult.
(At rest.)

FIGURE 44.
The fruit of *Attalea* from which the beetle has emerged.

FIGURE 45.
Caryoborus, adult.
(Walking.)

westerly upper current in this case would generally be the first indication of an "Antarctic" disturbance centred perhaps one to two thousand miles away. Again, there is one type of storm, the development and approach of which are extremely well indicated by cirrus movements—that of a tropical disturbance moving southwards from the interior of Queensland. When the barometer is very high, owing to an intense anticyclone moving eastward along the south coast-line, it occasionally happens that cirrus begins to stream southwards over Melbourne from points between north-east and north-north-east. This is an almost infallible indication of widespread rains having set in, or being about to set in, over southern Queensland and inland New South Wales, and a very good indication of general rains over Northern Victoria in the near future.

INTENSITY OF RAINFALL EXPERIENCED IN CEYLON.—The Ceylon Survey Department has commenced the issue of a new publication, entitled *Memoirs of the Colombo Observatory*. No. 1 is "On the Intensity of Rainfall experienced in Ceylon," by A. J. Bamford. This includes a map showing the maximum rainfall recorded in twenty-four hours, from which it is noticeable that the north and north-east coasts have undergone higher intensities than other parts of the island. This is due to the fact that those coasts are most subject to cyclones. The figure, 31·72 inches, from Nedunkerni seems fairly well substantiated. It stands among the highest records of the world, though it is by no means the highest. At Colombo the maximum recorded in one day is 11·62 inches, *i.e.*, roughly half-inch per hour. In *Symons's Meteorological Magazine* for January, 1916, Mr. J. E. Evans has given copies of the records from the pluviograph at the Colombo Observatory for July 12th, 1907, and for October 28th, 1915, on both of which days six inches of rain fell in *one hour*.

SCOTTISH METEOROLOGICAL SOCIETY.—The annual general meeting of the Scottish Meteorological Society was held in Edinburgh on December 21st, when Professor R. A. Sampson, F.R.S., was elected the President for the ensuing year. Mr. J. Mackay Bernard, the retiring President, gave an address on "Some Remarks on Meteorology," in which he discussed a wide variety of topics, amongst others the physical processes underlying the formation of rain; the problems of forecasting; the appearance of the sky as a weather prognostic, and some other popular points of view; the rain-band spectroscope and various types of weather-glasses. The popular belief that weather conditions had changed within historic times was, he said, not borne out by the evidence. The winter of 1614–15 was so severe and so prolonged, and the destruction of live-stock so great, that the use of lamb as a food was prohibited by law for a certain time. Again, in 1652 a wonderfully dry and warm summer was experienced, with the harvest completed in parts of Scotland early in July. The fine weather of 1652 lasted far on in the year, so that fruit trees blossomed and fruited again a second time, and "salads and sybous were cried and sold in Edinburgh on the 27th of November."

MICROSCOPY.

By F.R.M.S.

COCCIDIDAE, OR SCALE INSECTS.—In the examination of these insects the microscope is essential, as they are for the most part small, and to make out the details of their structure a moderately high-magnifying power is required. As a family they may be recognised by having a single claw on each foot, with a tarsus of one joint only; whilst the males, where known, have two wings and a pair of halteres, as in the case of the Diptera. Nearly a thousand species are already described; and, though the majority of these is found in warmer climates than our own, many kinds are common to this country; whilst others are frequently imported on foreign plants and fruits, a careful examination of which will often repay the microscopist who looks for them there. Amongst the British kinds there is perhaps nothing finer under the binocular microscope than *Orthesia* when well shown upon a dark green or blue ground with strong transmitted light, its brilliant whiteness and the symmetrical arrangement of the plates covering its dorsal surface rendering it a very striking object. This genus would seem to be fairly hardy, as I have met with it in considerable abundance on the under side of the leaves of the wood sage at an altitude of four thousand feet on the slopes of the Bernese Alps. In many genera the females during their later stages become fixed in their respective positions, and form tests or shields with which they cover themselves, their eggs, and their young. These tests are of great interest to the microscopist on account of their variety of form and structure, and the curious markings thereon, some being resinous, others chitinous or of a glassy nature, the most beautiful of the last-named (*Inglisia leptospermi*) coming from New Zealand, as one of the many Colonial species described by the late Mr. W. M. Maskell, and being both in shape and markings not unlike a miniature tortoise. Others, to which the common name of "mealy bugs" has been applied, are freely covered with a white flocculent, waxy, or cottony material, but retain both antennae and legs throughout life.

Recently I was fortunate in finding on a banana some specimens of these (*Dactylopius brevispinus*), alive and in perfect condition, notwithstanding the vicissitudes through which they had passed. Although individually so small, yet, owing to their great number, some of them are of importance as items of economic value. Such, for instance, are the cochineal insects from Mexico; the lac insects of the East; the *Ceroplastes*, which furnishes the pomade for bandolining the heads of the Zulus; the copious honey-dew deposited by a species of *Gossiparia*, used as food by the Arabs of North Africa; and the white candle wax of China. The "ground pearls" of St. Vincent are the tests of a species of *Margarodes*, which, being collected and made into necklaces or bracelets by the natives, are sold by them as such; which reminds me that a lady of my acquaintance, who owns such a necklace, but who has obviously not examined it under a microscope, still persists in describing it to her friends as being made of ants' eggs!

R. T. L.

THE ROYAL MICROSCOPICAL SOCIETY.—Recently the new President, Mr. Edward Heron-Allen, drew attention to the need of considering the future of the Royal Microscopical Society. The well-being of Societies which confer no direct professional status upon the members depends a great deal upon the personal effort and influence of one or more officers. Acting being always better than talking, Mr. Heron-Allen has in the meantime been at work. He organised a most interesting and successful exhibition of microscopes, at the meeting on February 16th, illustrating the evolution of the instrument. He stated that the Royal Microscopical Society would produce a much needed book on the subject, and he outlined a most attractive programme of discussions and papers.

CARYOBORUS NUCLEORUM is a beetle allied to the weevils, and its larva lives in the fruits of *Attalea funifera*, of which specimens were not long ago imported from Brazil, in the hope that they might prove of commercial importance. Mr. Hugh Main, who recently was awarded the medal of the Royal Photographic Society for his well-known work, has kindly furnished the photographs illustrating the life-history of the beetle, which are reproduced in Figures 39 to 45.

W. M. W.

XUM

THE QUEKETT MICROSCOPICAL CLUB.—The five hundred and thirteenth ordinary meeting took place on Tuesday, January 25th, 1916, at 20, Hanover Square, W., the President, Professor Arthur Dendy, in the chair.

The Honorary Secretary read a paper by Mr. G. T. Harris, of Sidmouth, on "The Collection and Preservation of Desmids." The paper referred to the frequent complaint of the uninitiated of their lack of success in obtaining desmids. It was remarked that this was due probably rather to the method of collection than to any real scarcity of the objects. Their presence in various situations was noted, and the fact that the ordinary ring net affected by collectors of microscopic organisms was not well adapted for use in many of them. Professor West's suggestion of clipping the stems of aquatic plants below water between the closed fingers, and carefully drawing upward the hollowed hand, to form a cup in which the flocculent matter is caught, came in for approval. If the collecting excursion is one of a day's duration only, the usual supply of tubes and bottles will suffice, and the material acquired may be brought home in the water in which it was found. But if the excursion is more extended, another method was recommended. The writer had found it of advantage in this case to kill and fix the plants on the spot, and filter the result, bringing home the concentrated residue in numbered tubes. For the filtering two or three small funnels could be made from "ferrotype" metal, and chamois leather had proved the most efficient material for use with these. When an amount considered sufficient has been put into a tube, it should be nearly filled with clear water, and about—exactness is not necessary—four cubic centimetres (for a 3-in. × 1-in. tube) of the following killing and fixing solution is to be added :—

Cupric sulphate (ten-per-cent. solution)	100 cubic centimetres
Mercuric chloride (saturated solution)	10 cubic centimetres

Mounting desmids is admittedly a tedious and uncertain process, but the author had found Harmann's platino-aceto-osmic solution gave very satisfactory results. It fixes and preserves the histological elements admirably. Naturally there is a little alteration in colour, but much less than occurs with other mediums. In using it a few drops are added to the desmids in half a watch-glass of water, and allowed to act for two or three minutes; then the desmids are transferred with a pipette to two or three succeeding wash waters, and finally mounted in a saturated solution of thymol. This is merely distilled water, which has taken up as much thymol as it will dissolve.

It was noted that many desired to preserve the natural green colour in their mounted specimens, although this was no great advantage for the purpose of identification or study; while the preservation of the histological details in their original condition, which was much more easily accomplished, was of the utmost importance for these purposes. Various methods having the preservation of the natural colour in view were tried, but the author had come to the conclusion that the following attained the purpose most satisfactorily. The desmids should be mounted in the water to which the preservative was added at the bog side. "Usually when filling up the tubes and bottles a certain amount of the fluid is superfluous. On reaching home this supernatant clear portion in each bottle is laid under contribution to accumulate a stock solution, which is filtered, and forms the mounting fluid. It will be seen, therefore, that the desmids are mounted in their own bog water, plus the small proportion of fixing agent. As far as the preservation of the green colour of the plant is concerned, nothing that has been tried has given such good results." It was stated that the use of a too shallow cell should be avoided, it being found that the small amount of fluid contained by it was more liable to become absorbed or to evaporate than the larger amount which a deeper cell would hold. It was also pointed out that the deeper cell permitted the plants to assume various positions and show different aspects, which is necessary in many cases for correct identification. The uncertainty which seems to attend all efforts permanently to mount desmids was commented upon, and many instances given. It was mentioned that *Netrium digitus* was particularly difficult, the protoplasm contracting on the least interference. It was almost impossible to preserve the colour in *Micrasterias rotata*; while in some—e.g., *Closterium costatum* and *C. striolatum*, and others naturally somewhat yellow—the alteration in colour is almost negligible. It was suggested that success or failure in the mount was very often the result of the age of the specimen, and also of its condition—healthy or otherwise—at the time of its collection.

A number of slides, showing desmids mounted by the author, and retaining their natural colour, was exhibited under microscopes on the table, and was much admired by the members for the perfect preservation of their structural details, as well as the natural colour.

A considerable discussion took place at the close of the paper, and one member, who had had some experience in mounting desmids, gave details. He expressed preference for a staining process, as it brought out histological details more clearly than the preservation of the natural colour, even when that was most successful. He also emphasised the uncertainty which characterised mounting these objects by any of the various methods tried.

The next ordinary meeting of the Club will be the annual meeting on February 22nd, when the President will give his annual address, which will be "On the Origin of Distinguishing Characters in Sponges."

J. B.

PHOTOGRAPHY.

By EDGAR SENIOR.

CLEARING AND REMOVING PORTIONS OF THE IMAGE ON BROMIDE PRINTS.—It frequently happens that the finished prints on bromide paper, "especially those having a glossy or semi-matt surface," exhibit thin hair-like lines or stress marks, as well as a slight grey deposit of fog, which mars the purity of the whites. The former of these can be removed by lightly going over the surface of the dried print with a piece of cotton-wool moistened with methylated spirit; the latter, however, requires chemical treatment for its removal. The method of clearing largely employed is the ferricyanide and "hypo" reducer originated by Howard Farmer. But in order to obtain satisfactory results certain precautions are necessary. The ferricyanide of potassium, which should be a ten-per-cent. one, must be made up and kept in the dark, and only added to the "hypo" at the moment it is required for use, as the mixed solution will not keep. The "hypo" solution of a strength of one ounce dissolved in ten ounces of water must be freshly made. When the bromide prints have been thoroughly washed, after fixing, the clearing solution is prepared by the addition of sufficient of the ferricyanide to the "hypo" contained in a white dish as will cause the solution to assume a pale yellow colour. The colour of the solution is the best guide as to the correct quantity to add, and a little experience will soon enable this to be gauged to a nicety. The solution must be used at once, as it quickly loses its strength; and if many prints have to be treated it may be found necessary to add more ferricyanide to cause it to continue to work. The point at which the bath loses its action is indicated by a change of colour, the solution assuming a bluish tint. The prints which require treatment are placed face up on a sheet of glass and the clearing solution applied with a wad of cotton-wool when any surface fog or stress marks will quickly disappear, and as soon as this occurs the print must be immediately washed in running water.

Prints which are over-exposed and developed too far may be cleared in a bath containing more of the ferricyanide in which case the whole print will be reduced. The tendency, however, of this reducer, when used too strong, is to reduce the finer tones in a greater degree than the darker ones, so that the method is not altogether to be recommended as a remedy for errors in exposure and development. When using the ferricyanide reducer for removing stress marks a very slight reduction of the whole print usually takes place. This, however, is often an advantage, as it gives purer high lights by removing any slight surface fog. When it is desired entirely to remove a portion of the image, or a background in a print, then the ferricyanide reducer should not be employed, owing to the staining effect which results from its use. By far the best reducer for the purpose will be found in iodine and potassium cyanide. With most makes of bromide paper this can be used full strength without the slightest stain being imparted to the paper. Various formulae for the solutions have been published, but the following will be found as good as any :—

No. 1.

Potassium iodide	96 grains
Water	1 ounce

No. 2.

Potassium cyanide	48 grains
Water	1 ounce

To No. 1 as much iodine is added as the solution will dissolve, allowing any undissolved portion to remain at the bottom of the bottle. It is quite possible to reduce a print with potassium cyanide alone, but the addition of the iodine makes the action very rapid and clean. The proportions in which the solutions should be mixed will depend upon the nature of the work to be done ; but, assuming that an entire background requires to be reduced away, then about five minims of No. 1 to one ounce of No. 2 would be suitable proportions in which to mix them. If the solution works too slowly, more of No. 1 is to be added. Prints that are going to be reduced should be dried before they are worked upon, otherwise blisters may make their appearance ; and in cases where parts of the image are to be removed entirely the reducing solution should be applied directly to the dried print by means of a camel-hair brush, care being taken not to go too closely up to the outline at this stage, as a hard line will be left, which must subsequently be softened off. Having done this, the print must be well rinsed under a stream of water from the tap, and then laid upon a sheet of glass, and the surface wiped with a wad of wet cotton-wool or blotted off. The wool must be squeezed as dry as possible, and the surface moisture wiped off the print as it lies upon the glass. This being done we proceed to soften any hard edges, and shade off where required. To do this a brush is charged with a weaker solution of iodine and potassium cyanide, and then applied to the darker edges, when it is almost immediately washed off with a piece of wet wool, the operations being repeated until the desired effect is obtained. For the lighter portions of the print the reducing solution should be employed weaker still in order to get delicate gradations. Hard vignettes can be greatly improved by applying a weak solution of the reducer to the wet print by means of a piece of the cotton-wool ; but it is necessary that a plentiful supply of running water be immediately available to arrest the action of the reducer, and that all prints treated with potassium cyanide should be finally very thoroughly washed. This method of reduction will be found useful in many ways, which will readily suggest themselves to the worker. As an example, we often see a subject which would make an artistic photograph by itself, but which is more or less spoilt by its surroundings ; and if these be removed by the method described, a more pictorial effect would result. To those, however, who may be inclined to experiment with this method of reduction a word of warning must be given as to the extremely poisonous nature of the solution ; in fact, this is the only possible objection to its use. Great care must therefore be taken, and the operations conducted in a well-ventilated apartment.

PHYSICS.

By J. H. VINCENT, M.A., D.Sc., A.R.C.S.

DRIFT PROBLEMS IN OPTICS.—When light passes through a substance, such as glass or water, the velocity of propagation is less than that in a vacuous space, the ratio of the velocity in a medium to that in free space being the reciprocal of the refractive index. This is in accordance with the wave-theory of light, and has been verified by the experiments of Foucault and of Michelson. If now the transparent medium is in a state of steady motion along the direction in which the light is travelling, we should expect that the velocity of the light as measured by apparatus not partaking of this motion would be increased or decreased according as the matter moved with or against the direction in which the light travelled. Experiments by Fizeau showed that this is indeed the case : the light drifts with the moving matter. The effect is to add a velocity to that of light in the stationary medium, this added velocity being found to be about v/n^2 less than the velocity (v) of the medium in which n is the refractive index. The experiments of Fizeau thus supported the theory of Fresnel, who deduced that the drift-velocity should fall short of the velocity of the medium by v/n^2.

RECENT WORK ON DRIFT PROBLEMS.—The exact relation to be expected between the added velocity of light in a moving medium and the velocity of the medium was discovered by Lorentz, who obtained a formula which, while in the main agreeing with that of Fresnel, differed from it in containing a term depending on the change of the refractive index with the wave-length. Lorentz's correction in the case of water makes the expected drift-velocity about three per cent. larger than that given by Fresnel's theory. The correction, though small, is of great interest, since drift experiments are the only ones concerning the motion of matter and ether which yield positive results. Lorentz's formula is also in accordance with the principles of relativity.

Zeeman has recently subjected the matter to refined experiment, and finds that his results are conclusively in favour of the Lorentz correction (*Nature*, December 16th, 1915).

SPARKING POTENTIALS.—Owing largely to the difficulty of accurately measuring high differences of potential, the results of different experimenters, who have given corresponding electrode distances and potentials, are not in strict accord. The method of determining potentials by ascertaining the sparking distance is, however, a valuable one, and for many experimenters is the only one available owing to the lack of suitable measuring instruments. The table of sparking potentials given by the Committee of the Röntgen Society in their interim report on the standardisation of x-ray dosage will be found very useful by all who wish to employ this method of measurement of potential. The table gives the values for needle-point electrodes for alternating current of sine form ; the potentials being the maximum values, the corresponding voltmeter or root mean square values are found by dividing by 1·4. These values go from one thousand volts, which give a spark of one millimetre, to two hundred and twenty thousand volts, giving a forty-centimetre spark. In addition, for direct current or steady potentials, four series of results are given for smooth polished metal balls of ·5, one, two, and five centimetres diameter respectively. The sparking potential for one centimetre spheres, one centimetre apart, is thirty-one thousand volts. The direct voltage tables go up to one hundred and ninety thousand volts for five centimetre balls, twenty centimetres apart. (For tables, see page 281, *Archives of Radiology and Electrotherapy*, January, 1916.)

XUM

VACUUM TUBE SPECTRA.—It has been known for some time that when metallic vapours, such as those of cadmium and mercury, are present in a vacuum tube as impurities the spectra of these metals may be produced in strength; while the spectrum of the gas constituting the bulk of that still present in the tube may be considerably diminished. One molecule of mercury for every three thousand of hydrogen will cut down the light of the hydrogen spectrum by one-half. If there is an appreciable difference between the atomic weights of the gases present in a vacuum tube, the spectrum of the heavier element masks the spectrum of the lighter. In the case of a gas whose spectrum is masked by that of another, it is interesting to enquire to what extent it takes part in carrying the current through the gas. It turns out on investigation that a gas whose spectrum in the positive column is masked by the spectrum of another gas may still be taking a very important part in carrying the current in the dark space (Smith, *Phil. Mag.*, December, 1912).

GAS-FILLED TUNGSTEN GLOW LAMPS.—Instead of a vacuum, the space surrounding the filament of tungsten in these lamps is filled with gas. Nitrogen is used in the larger sizes, and argon in the smaller. For small lamps the gas has to have a low thermal conductivity. Therefore argon was used in preference to nitrogen. But it was found to be desirable to add a small admixture of nitrogen, since argon had no great power of resisting electrical discharge, and lamps filled with pure argon were liable to short-circuits.

The gas pressure, when the lamp is cold, is about one-half or two-thirds of an atmosphere. Even when hot there is no great excess of pressure, and therefore no fear of an explosion (Pirani and Meyer, *Electrician*, December 10th, 1915).

RADIO-ACTIVITY.

By ALEXANDER FLECK, B.Sc.

RÖNTGEN SOCIETY.—In the January issue of the *Journal* of this Society the opening address, which was delivered by the new President, Mr. J. H. Gardiner, is reprinted. It consists chiefly of a review of the main facts in the development of the science of x rays, of radio-activity, and of radiant matter generally. It can be heartily recommended to those who wish a clear, short, and accurate statement of the steps which have brought us to our present position in these matters.

With the same issue of the *Journal* the Society sends out a card giving warning of the very harmful results liable to follow misuse of x rays. At a time such as the present, when there are throughout the country a great many x-ray operators having comparatively little experience, this warning comes very opportunely.

ELECTRO-CHEMISTRY OF RADIUM-G.—Hevesy and Paneth in Austria are continuing their work on the electro-chemistry of the radio-elements. Their latest paper, in the *Monatshefte* (1915, page 795), is on galvanic cells, in which lead compounds are interchanged with the same compounds of radium-G, one of the isotopes of lead. The cell used was of the type, platinum, lead peroxide, lead nitrate in nitric acid, comparison electrode, and the results show that if radium-G be inserted in equal concentration, instead of the lead in either compartment, the potential difference is not altered more than ten micro-volts. When the comparison electrode is removed, and replaced by a radium-G nitrate solution, a direct measurement should be obtained of the potential difference between lead nitrate and radium-G nitrate. When this experiment was made the value obtained was less than one micro-volt.

The electro-chemical as well as the ordinary chemical identity of isotopes has been established before, and therefore these experiments afford additional interesting evidence of this fact.

ZOÖLOGY.

By PROFESSOR J. ARTHUR THOMSON, M.A., LL.D.

WHITE-HANDED GIBBONS.—A Swedish naturalist, Nils Gyldenstolpe, made some interesting observations on the gibbons (*Hylobates lar*) of the primaeval forests of Siam. They are common and gregarious, but are rarely seen by Europeans, who cannot penetrate the tangle of vegetation with the noiselessness of the natives. The gibbons are extremely shy, and move with great rapidity. Mr. Gyldenstolpe was fortunate enough to get a view of about a score feeding and playing. They were mostly black, but some belonged to the white variety. They seem to keep quiet during the day, but they indulge in loud wailing chants just before sunrise, especially when a faint mist spreads its covering veil over the hills and forests. Some notes on three half-tame gibbons are communicated. When walking—which was seldom—they always balanced with their long arms stretched upwards. When drinking, they always scooped up the water to their mouth with their hands. But if they were disturbed when eating fruit, such as bananas, they escaped up a tree, holding the fruit in their feet, and never using their arms except for climbing. The young one keeps close to its mother for a long time, hanging to her breast.

BUGS LIKE BIRD-DROPPINGS.—In 1885 Dr. H. O. Forbes observed a Malayan spider (*Ornithoscatoides decipiens*) which was like a bird-dropping on a leaf, and had captured a Hesperid butterfly, which had been mistakenly attracted. It seems that Lycaenid butterflies are often attracted to excrementitious material, and Dr. G. D. H. Carpenter has recently reported to Professor Poulton the case of a Uganda bug which closely resembles a bird-dropping and sand, and actually sat on a bird-dropping on wet sand, "presumably for the express purpose of catching Lycaenids which came to feed there." It was not disappointed, and the suggestion is offered that the resemblance of the bug to a bird-dropping may tempt Lycaenids to alight on it.

EXTINCTION OF SPECIES.—Many suggestions have been made in regard to the causes which bring about the extinction of species. In some cases perhaps the times change, and highly specialised creatures are not plastic enough to change with them. Sometimes the invasion of a territory by some new enemy involves the doom of old-established tenants. According to some authorities, species grow old as individuals do. Sometimes the answer is simple enough, for man's ruthlessness is to blame. The subject has been recently discussed by Professor V. Hensen, who holds that the death-blow may be often due to in-breeding and the associated accumulation of harmful by-products. In this connection he refers to the case of the rainbow trout (*Trutta iridea*), which was brought to Europe from California about 1880. For a while it flourished well, and seemed very resistent. Gradually, however, it lost its grip. The germ-cells of both sexes degenerated before complete maturity, and diseased conditions became common. The liver cells, for instance, became encumbered with fat, and the secretion of bile was interfered with.

TERMITE-RAIDING ANTS.—Mr. C. O. Farquharson—an Aberdeen student—has made some very interesting observations on large ants in South Nigeria, which form small armies, and make war on termites. One line was about fifteen feet in length, and included about five hundred individuals, most of them carrying a termite soldier. When disturbed they broke into loud hissing, "almost like water on hot metal." The march was more regulated than that of the driver ants, which show somewhat frenzied bustle. "No particular ant seemed to be leader, but there was an extraordinary atmosphere of purpose about their march. Once or twice they would hesitate, and the leaders would scatter, soon to reunite and continue the march." The species seems to be *Megaponera foetens*, the specific name

referring to the offensive odour which they emit when molested. Another "Stink Ant" is *Paltothyreus tarsalus*, which also forages in files and raids termites. In both species, according to Mr. G. Arnold, the hissing is "plainly audible at a distance of several feet"; in both the sting is exceedingly painful. When *Megaponera* attacks a termitary, each ant retrieves about half a dozen termites, and brings them maimed to the surface. The whole army reassembles outside, and each marauder goes off with three or four victims. Mr. Arnold has described (*Annals South African Museum*, 1915) a migration of *Megaponera* from an old nest to a new one, about sixty feet distant. About every fifteen feet the party halted and waited for all the eggs, larvae, pupae, and most of the stragglers.

HOMING OF TERNS.—An important experimental contribution to the study of homing in birds has been made by Professor J. B. Watson and Dr. K. S. Lashley with reference to the noddy tern (*Anous stolidus*) and the sooty tern (*Sterna fuliginosa*), which nest in tens of thousands on Bird Key, in the Tortugas. They show that if these birds are transported on board ship right into the middle of the Gulf of Mexico, where there are no landmarks, they may return safely to their nests. Safe returns were made from off Cape Hatteras, eight hundred and fifty miles to the north (far beyond the northern migratory limit of these tropical terns), and from Galveston, eight hundred and fifty miles to the west. A return from the open sea was just as effectively made as from the coast. The authors have no solution to propose, but they are disinclined as yet to assume any new or mysterious sense.

FORMATION OF HABITS.—Of great interest to the zoölogist is the problem of the formation of habits, which has to do with the establishing of "neural pathways." One of the latest investigations, but relating to man, is a study by Dr. K. S. Lashley of the acquisition of skill in archery. The rate of learning was studied in two groups of men—one of the artisan, the other of the professional class—but no significant difference in the rate of learning in the two groups was found. A close correspondence was demonstrated between the distribution of practice and the amount of improvement, a given amount of practice being more efficient when distributed through many short periods than when concentrated in a few long ones. It is not as yet clear on what this important relation depends. It may be due partly to the dulling effect of fatigue; partly to the need of a period of rest, if newly formed associations are to become fixed; partly to the fact that the subjects of experiment, if interested, are usually given to thinking and talking about their growing skill in the periods between practice; partly to the value of the fresh interest at every fresh start; and there are probably other conditions. But the general fact is certain that practice distributed over many days is more economical than when concentrated to a few days.

NIATA CATTLE.—In his "Voyage of the 'Beagle'" and elsewhere Darwin discussed this curious breed of South American cattle, and attributed their rarity and probable extinction to the abnormal bull dog-like formation of the lips, which made browsing difficult in short pasture. Mr. Ernest Gibson reports that the career of the breed is now nearly, if not quite, ended. The quaint breed appears to have arisen as a variety of the *Bos taurus* species, introduced into South America by the brothers Goess in 1558, and corresponding variants have been noted in Europe. The skull of an old Niata cow has been presented to the British Museum by Mr. Gibson, and it seems to be the last of an unsuccessful experiment. The cow was kept in a paddock at the back of Mr. Gibson's office, and used to gaze through the windows. "I confess," he writes, "that I never glanced up on feeling the shadow cast on my desk, and met the aspect of her extraordinary visage in such close proximity, without experiencing a distinct thrill and shock of almost terror." She died in due time of sheer old age.

RHEOSTATS.

IN many applications of electricity to industry rheostats are an essential part of the plant, while, in the electrical testing room and laboratory, facilities for the insertion of suitable resistances into circuits are absolutely essential. In their new catalogue of rheostats Messrs. Isenthal & Co., of Denzil Works, Willesden, N.W., describe and figure a variety of well-designed apparatus suitable for commercial and laboratory purposes. All the rheostats may be supplied with graded winding, that is, instead of winding the whole length of the slate or tube, as the case may be, with one gauge of wire, the winding space may be subdivided into a number of spaces, each of which carries wire of a different thickness. In this way a very large range of adjustment and very fine regulation is attained. In the tubular rheostats the wire is oxidised, so that it may be wound with the turns in contact. The oxide is unaffected by heat, and forms a lasting insulating layer effectively separating the successive turns. This firm has a high reputation both for the sound workmanship of its goods and its readiness to apply recent scientific advances commercially. We hope that British firms will be able to secure such a hold on this branch of electrical industry during the war as to defy competition when peace returns.

VEGETABLE-MARROW SEEDLINGS.

As a subject for study in practical botany, the vegetable-marrow plant will be found of considerable usefulness and interest. It shows many details of structure with ease, and some even to the naked eye, while in respect of the arrangement of the tissues of the stem it departs from the usual dicotyledonous type. The seed is of good size, and the opening, or micropyle (left in its coats when it was merely an ovule containing an unfertilised egg cell), is large and easy to find. Figure 35 on page 61 shows the radicle of the embryo, within the seed, making its way out through the micropyle. The coat, or testa, is labelled in the figure, as is also the hilum, or scar, which marks the point of attachment to the fruit. The seed belongs to the type in which there is a considerable amount of food stored up in the seed-leaves of the embryo. Seedlings can be grown in sawdust, so that they may be examined without injury. An interesting feature of the marrow, and one which has been pointed out for the benefit of the nature student, is the peg (see Figures 36 and 37) which grows out of the hypocotyl, or stem, of the embryo, and holds the seed-coat in or on the soil, so that the seed-leaves can be withdrawn, and can separate when they get into the air and light. If the peg fails to work, the leaves are encumbered for a long time by the seed-coat. The figures show the various external details of the growing seedling.

W. M. W.

XUM

A SIMPLE LINE-DIVIDING INSTRUMENT.

By A. BURSILL, B.Sc.(Eng.), A.M.I.E.E.

(*L.C.C. Paddington Technical Institute.*)

It is frequently necessary in drawing-office work to divide a line into a given number of equal parts, or to divide a line in a given ratio. When the line is of such length that its measure is readily divisible by the required number of parts, the draughtsman generally adopts the plan of finding the length of the part by arithmetical division, and measuring it off by means of his scale. Very often it happens, however, that the measure is not readily divisible, and the draughtsman is then compelled either to use a geometrical construction, to find the approximate length of the part by arithmetic, or to find the required part by trial with the aid of a pair of dividers. The last, and least scientific, method is probably used most frequently in practice, owing to the natural tendency for a workman to use the tools most readily to hand in carrying out his work.

The purpose of this article is to describe a simple instrument which enables the subdivision of a straight line to be carried out by the geometrical method with great facility and in a minimum of time.

Suppose it is required to subdivide the line AB (see Figure 48), of length, say, four inches, into seven equal parts; then the well-known construction is as follows. Draw the line AC of any length and at any angle to AB. From A cut off seven equal parts of any length along AC. Join the last point D to B, and from each of the other points draw lines parallel to DB, and cutting the line AB. These lines will divide the line AB into the required number of equal parts.

Now it is clear that the same result could have been obtained if a series of equidistant lines had been drawn on tracing paper and adjusted to AB, so that line No. 0 passed through A, and line No. 7 through B. The points of division could have been then pricked through the tracing paper.

The instrument devised by the present writer can be used to carry out the division even more readily, and certainly more accurately, than the tracing paper. It consists, in its simplest form, of a sheet of celluloid formed into a series of equidistant parallel straight-edges by having a number of slots cut in it. The straight-edges are bevelled to make drawing more convenient, and the last of the series is one of the bounding edges of the celluloid sheet. In Figure 2 the instrument is shown dividing the line AB into seven equal parts. In order to do this the point of the pencil is put through slot No. 0 and placed upon the extremity A. The edge No. 0 is then pressed against the pencil point, and the line-divider rotated until edge No. 7 passes through B, due allowance being made, however, for the thickness of the pencil point. The instrument is then held firmly in position, and the pencil drawn along edge No. 7. If the line so made passes through the point B, the correct allowance has been made for the thickness of the pencil point. After testing, to see that this is so, the other points of division are marked on the line at the appropriate straight-edges.

By omitting all other marks except that at edge No. 3, the line is at once divided in the ratio 3 : 4, and, naturally, the line can be divided in other simple ratios in a similar manner. It will readily be seen that a line may be divided either internally or externally by the aid of the instrument.

The instrument shown in Figure 47 is of rectangular form (18×13·5 centimetres), and the distance between consecutive working edges is one centimetre, the length of each edge being fifteen centimetres, so that the maximum length of line that can be dealt with is $\sqrt{15^2+12^2}$, or just over nineteen centimetres, and such a line can be divided into twelve equal parts. Of course, the shortest division that can be obtained in any case will be the distance between consecutive straight-edges—in this case one centimetre. It follows, therefore, that an instrument of this particular design has a somewhat limited range of usefulness, and it has been described, first, because it will render the method of use of a slightly more complex instrument almost self-evident, and because of its educational value in illustrating the geometrical principles involved to young students.

In the rectangular form, the range of the instrument cannot be very extensive, owing to mechanical considerations. Thus, to make the possible length of line a maximum, the edges must be as long as possible; and to make the least division as short as possible, the bars must be narrow. Both these methods of increasing the range tend to make the bars flexible, and cause inaccuracy and possibility of breakage.

In order to obviate these difficulties, the drawing-office type of line-divider is made in the form of a forty-five-degree set-square, having the two equal edges 24·5 centimetres each. The edges from 0 to 5 (see Figure 46) are a half-centimetre apart, from 5 to 12 are one centimetre apart, and the remaining edges, which are long and must have considerable strength, are separated by two centimetres. In this way the bars are all of great rigidity, so that accuracy is obtained. It is not, of course, absolutely essential for the instrument to be made of celluloid; but it is advisable, on account

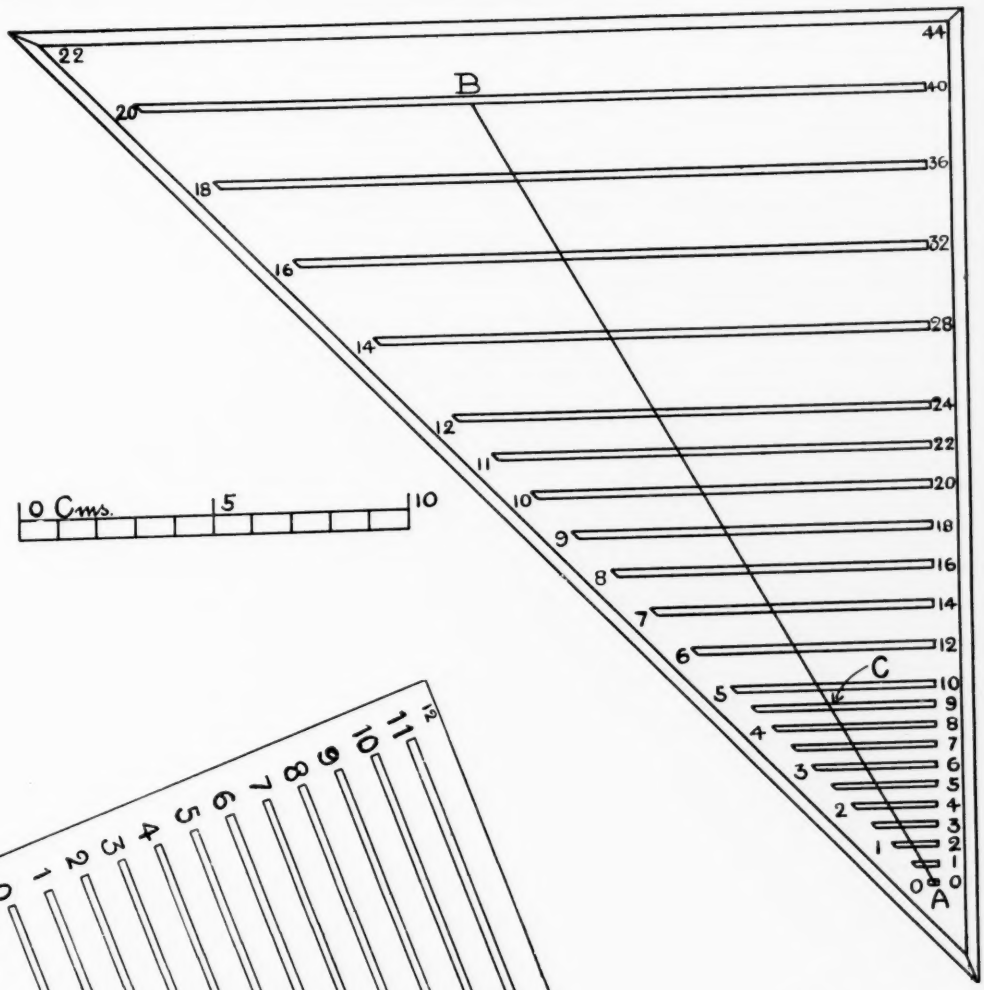

FIGURE 46.

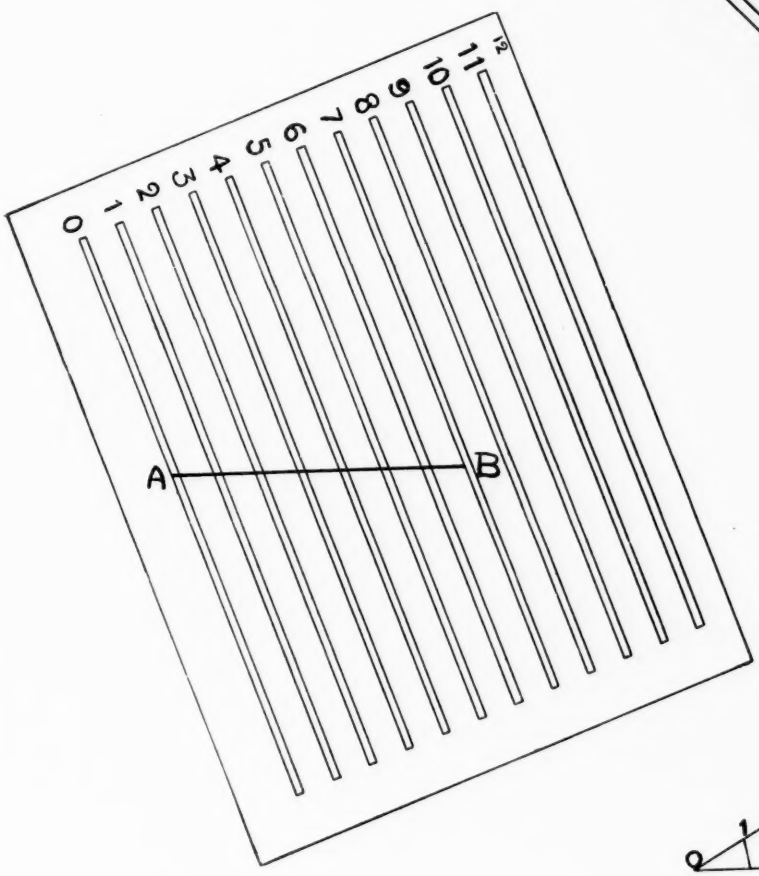

FIGURE 47.

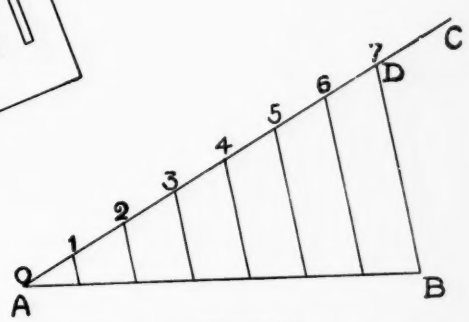

FIGURE 48.

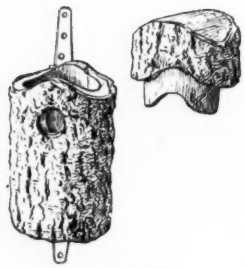

FIGURE 49.

FIGURE 50.

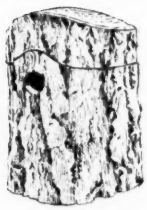

FIGURE 51.

These belong to the type of Nesting Box which has been found to be most generally successful and useful. Figure 51 is intended to be lifted down from a nail in nature-study work.

FIGURE 52.

A box for birds that like cover but not darkness.

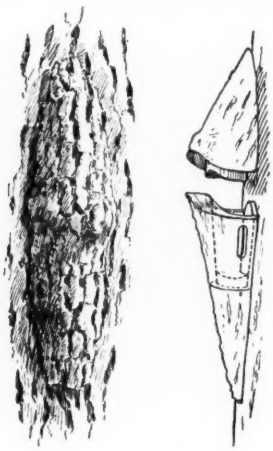

FIGURE 53. FIGURE 54.

A very inconspicuous box intended for tree creepers, and made from a branch with an elbow. It is liked by wrens and blue-tits.

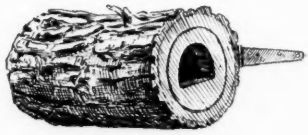

FIGURE 55.

This box can be used when it is not required to see the inside of the nest.

FIGURE 56.

FIGURE 57.

Bracket tray and basket for blackbirds and thrushes.

FIGURE 58.

For the same uses as Figure 52.

FIGURE 59.

FIGURE 60.

Open and covered trays for blackbirds and thrushes.

FIGURE 61.

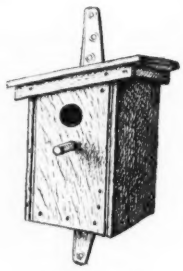

FIGURE 62.

Types of board boxes for the same birds shown in Figures 49 and 51.

FIGURE 63.

FIGURE 64.

Mr. S. W. Abbott's observation box for watching the building of the nest.

NESTING BOXES FOR BIRDS.

of the greatly increased facility of use if it is made transparent.

With the final design of line-divider shown, the greatest length of line divisible is thirty-one centimetres, and the shortest length of division is half a centimetre. The diagram shows a line AB, of length twenty-three centimetres, being divided into ten equal parts. It will be noticed that in this position the point C divides the line in the ratio 9 : 31, which would be difficult to do with both speed and accuracy without the use of the line-divider.

THE ENCOURAGEMENT OF INSECT-EATING BIRDS.

JUST five years ago we published an article on the encouragement of insect-eating birds,* and reproduced a number of photographs of nesting-boxes which had been designed as a result of experience gained in the Brent Valley Bird Sanctuary.

One of the chief intentions was to improve upon and replace the nesting boxes which were being imported from Germany, and the various designs made were subjected to rigorous tests in the Bird Sanctuary; in fact, they were put up very late in the season, and in the most frequented parts of the wood. The simple forms were most successful; some of the more complicated types have been discarded. New ones have been introduced, and Figures 49 to 64 show those which are most generally made. It will be seen from the examination of Figures 63 and 64 that it is quite possible for the nature student to watch the actual process of nest-building by means of Mr. S. W. Abbott's observation boxes. Figure 49 shows the most generally useful form, and Figures 53 and 54 illustrate a design which was made by the present writer, in which, by using a branch with an elbow in it, a box can be produced which when fastened to a tree trunk is not at all easy to see. As in the near future more crops will be grown in this country, and there will be more need for insect-eating birds to feed upon insect pests, the use of nesting boxes will undoubtedly spread. Nesting sites have already been furnished with good effect in newly afforested districts; and if foreign competition is removed altogether, the industry of nest-box making should become more important. Incidentally it may be said that the sale of nesting boxes by the Brent Valley Bird Sanctuary Committee has been a material help to it financially in its work, and that boxes have been sent, not only to all parts of the British Islands, but to many countries abroad. The undersigned would be glad to give any information that he could on this subject.

WILFRED MARK WEBB.

REVIEWS.

EVOLUTION.

Evolution.—By J. A. S. WATSON, B.Sc. 157 pages. 146 illustrations. 9¾-in. × 6¾-in.
(T. C. & E. C. Jack. Price 5/- net.)

This volume is the first of a series, called "Through the Eye," of which it is said that the books will lie to a large extent on the profusion of illustration to "elucidate the text." Even before reading this description, a glance through the book gave the impression that it contained more pictures for its thickness than any one which we have seen before. It must be said at once that they are exceedingly clear, and fulfil their purpose admirably.

The letterpress seems sound, and not only will a reader get an idea of evolution, as he is intended to do, but also a very graphic account of the more important groups of the animal kingdom.

W. M. W.

GARDENING.

In a College Garden.—By VISCOUNTESS WOLSELEY. 255 pages. 8 illustrations. 8-in. × 5½-in.
(John Murray. Price 6/- net.)

The war has made even more important the training of women for work on the land, and the institutions where this is carried on. The writer has followed with interest the career of Lady Wolseley's College of Gardening at Glynde, and saw the ground on which the garden has been made, in its early days. Stages through which this progressed are described in the second chapter.

Although much of the book deals with the college at Glynde, a great deal of practical information is given, and there are parts occupied with such subjects as "what women gardeners are wanted for" and "what women in Canada are doing for their country." There is even a chapter on the ancient Sussex game of stoolball, which is a very interesting survival. We sincerely hope that those who are thinking of working on the land will take advantage of Lady Wolseley's book, and that others will follow her example, and found similar colleges in different parts of the country.

W. M. W.

GEOLOGY.

Engineering Geology.—By H. RIES and T. L. WATSON. Second edition. xxvii+722 pages, with 104 plates and 249 figures. 9-in. × 6-in.
(New York: John Wiley & Sons. London: Chapman and Hall. Price 17/- net.)

Of late years much attention has been paid by engineers to the general principles and applications of geology, with most beneficial results. The present work is the outcome of the authors' experience as teachers of geology from this point of view in American universities. It gives an excellent account of the chief points of the science, more particularly referring to those which have a direct practical bearing, without, however, neglecting matters of mainly scientific interest. The book is essentially American in its scope, the references to other parts of the world being scanty. This, of course, detracts to some extent from its value to students in other countries. Nevertheless, it cannot but be of value to engineers in all parts of the world, since the expositions are very clear, and are much assisted by the numerous excellent illustrations and maps. Perhaps the weakest part of the whole book is the chapter on Historical Geology, which has been added since the publication of the first edition. It was a difficult task to compress this branch of geology into some fifty pages, and one almost impossible of successful accomplishment. On the other hand, the chapters on Building Stones, Coal, Natural Gas and Oil, Ore Deposits, and other substances of economic importance are worthy of the most careful study. There is likewise an excellent account of the structural features of rocks and of their bearing on engineering problems. A considerable amount of attention is paid to the graphic and geometrical methods which have been found so useful in locating the position of concealed rocks and mineral deposits of economic value. The bibliographies at the end of each chapter, though comprehensive, refer almost entirely to American works, many standard European textbooks of world-wide reputation not being mentioned. This is particularly noticeable in the chapter on Ore Deposits.

R. H. RASTALL.

* "KNOWLEDGE," Volume XXXIV, page 99.

XUM

A Text-book of Geology. Part II : Historical Geology.—By CHAS. SCHUCHERT. 622 pages. 40 plates and 211 figures. 9-in. × 6-in.

(New York : John Wiley & Sons. London : Chapman and Hall. Price 12/-.)

This book is intended to give a general survey of the sequence of events in the history of the North American Continent. The writer begins with a short account of the origin of the earth and of the modern views on diastrophism : this is one of the keynotes of the book, all the transgressions and retreats of the oceans being referred to their proper places in the diastrophic cycle. The treatment of the stratigraphical systems is carried out on very broad generalised lines; the chief events are given due prominence, while there is a refreshing absence of the overwhelming mass of details, measured sections, etc., which are so common in books of this kind. The method of treatment is to describe generally the distribution and character of the sediments in North America, especially with regard to the positions of the chief land areas which supplied the material, and the seas in which they were deposited ; to give an account of the mountain-building movements, and their effect on the rocks, together with the chief igneous phenomena ; to review the chief characteristics of the life of the period ; and to compare and contrast the development of the system in Europe with that in America. With every system are given several palaeographic maps of North America, and similar maps of the whole world are supplied to illustrate the more important periods of world history, periods of mountain building and of glaciation. The account of the rise and development of life is very good. Not only is the life of each period described, with the rocks to which it belongs, but other chapters, dealing with such subjects as the rise of the fishes, of land floras, etc., are introduced at the periods when these events were taking place. On the whole the book is one of great interest, alike to the English as to the American student of geology. It is written in a very readable style, and will be welcomed by those in England who wish to obtain a working knowledge of American stratigraphy without going very deeply into details, which, as a rule, only serve to confuse the European student.

W. H. W.

Determinative Mineralogy.—By J. Volney Lewis. Second Edition. v+155 pages. 68 figures. 8-in. × 5-in.

(New York : J. Wiley & Sons, London : Chapman and Hall. Price 6/6 net.)

The second edition of this work has been somewhat enlarged by the addition of some new matter, including more delicate tests for certain elements that are, as a rule, difficult to identify in minerals, while some minor corrections and revisions have also been made. More than half of the book consists of tables for the laboratory determination of minerals. The varieties dealt with are three hundred and eighty in number, including all those likely to be met with in ordinary work. The basis of the methods described is mainly chemical, although a full account is also given of the more important physical properties. This is essentially a reference book and laboratory manual ; even the descriptive portions consist largely of abbreviations. These, however, are simple and clear, and the book will be very useful to geologists and mineralogists, as well as to mining engineers and prospectors.

R. H. R.

MAN.

The Antiquity of Man.—By ARTHUR KEITH, F.R.S. 519 pages. 189 illustrations. 8¾-in. × 5½-in.

(Williams & Norgate. Price, 10/6 net.)

The problem of the antiquity of man is dealt with by Professor Keith from the anatomist's point of view, and he says that he intends his book to be supplementary to Lord Avebury's " Prehistoric Times." We would rather use the word " complementary," for the volume before us should for a long time be the standard work on the structure of early man.

The conclusion arrived at by Professor Keith, as a result of the most careful consideration of existing evidence, is that man, differing but little in brain capacity from the people of to-day, existed in the Pliocene period, that is, roughly, a million years ago. Pithecanthropus is presumed to have budded off from the humanoid stem in Miocene times, and Heidelberg man is considered to have been an ancestor of Neanderthal man, who belonged to a species that has died out and left no descendants, though it long survived side by side with much less primitive men.

Professor Keith's starting-point is a Neolithic community of Kent, and he takes these people as a standard for subsequent enquiries regarding the bodily features of ancient races of men. Tilbury man is next described as an example of the " People of the Submerged Forest." We are taken out of this country during the consideration of pre-Neolithic and Palaeolithic men and their various stages of culture, but we come back from time to time, and to examine Galley Hill man and Ipswich man. Later, after ancient peoples of Africa, Java, and America have been dealt with, we again come to England in connection with the celebrated Piltdown skull. To the consideration of this the oldest of human remains, Professor Keith devotes nearly two hundred pages. He compares Dr. Smith Woodward's and his own reconstructions of the skull, and makes out a good case for the former not giving the proper size and height to the brain-case. Professor Keith dwells upon every detail with the utmost minuteness and care ; for, as he says, we have an opportunity of learning the condition of man's brain at the beginning of the Pleistocene period.

The illustrations to the book are most numerous and most useful, and the genealogical trees are made to grow through the geological periods ; all the branches which have reached the present day are of the same height. The part that our countrymen have played in the work of discovery is well brought out from 1797, when John Frere collected and described flint-spear heads, down to the finding of the Piltdown skull by Charles Dawson ; while Professor Keith begins his chapter dealing with the last discovery, with the words, " England owes much to the disciples of Gilbert White."

W. M. W.

NOTICES.

THE MOON.—Mr. John Murray has just published a remarkably cheap reissue of Nasmyth and Carpenter's classic work, *The Moon*. To offer a book of this status, consisting of over three hundred pages, with twenty-six plates, diagrams, and so on, for half-a-crown would be noteworthy in normal times ; under prevailing conditions it is little short of phenomenal. We advise those of our readers who do not already possess the volume to avail themselves of the present unique opportunity of securing it at a nominal cost.

TOBACCO FROM CYPRUS.—In former times the tobacco-growing industry in Cyprus was of some importance, but latterly it had practically disappeared. In 1905 the Director of the Imperial Institute, who visited the colony at the request of the Secretary of State for the Colonies, suggested that this industry should be revived. It is satisfactory to note that this suggestion has borne fruit. Now that the Turkish suzerainty of Cyprus has been removed, and the island has become a British possession, the industry may be expected to make rapid progress.

XUM